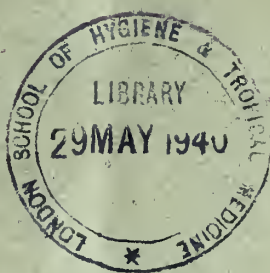


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ON THE RELATION
OF
COW-POX AND HORSE-POX
TO
SMALL-POX.

A THESIS READ FOR THE DEGREE OF M.D. CANTAB.

BY
ROBERT CORY, M.D.



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ON THE
RELATION OF COW-POX AND HORSE-POX
TO
SMALL-POX.

THE view that cow-pox and horse-pox are simply modifications of small-pox, and owe not only their origin but continued existence to it, is one which has commended itself to many since Jenner's time, for it accounts readily for most of what I may call the peculiarities both of cow-pox and horse-pox, and it saves us from many difficulties which meet us on the contrary supposition, viz. that cow-pox is an independent disease.

A good instance of these difficulties and how they are met is seen in Dr. Ballard's prize essay on 'Vaccination,'¹ pages 32 and 33 ; where he, while admitting that the cow can be inoculated with small-pox virus, and that the lymph collected from the resulting vesicles is so modified that it no longer produces small-pox, but only cow-pox, yet explains it on the theory that they are independent diseases, by supposing, on the one hand, that the cow is incapable of developing small-pox, therefore, when the cow is inoculated with small-pox virus, it is *cow-pox which is produced* ; on the other hand, he supposes that man is capable of developing both his own special disease—small-pox

¹ 'Vaccination, its Value and Alleged Dangers,' a Prize Essay, by Edward Ballard, M.D., 1868.

—*and* the varioloid disease of the cow. Hence that cow-pox, however arising *in the cow*, whether by the direct inoculation of small-pox virus or in the ordinary way, remains cow-pox when transmitted to him.

A right understanding of this matter is one of great practical importance, for if it be true that cow-pox is but modified small-pox, then no longer must we regard the human body as a soil foreign to the vaccine virus, but rather the cow's, and thus a weighty argument now used in favour of animal vaccination¹ would have to be transferred to the opposite balance.

Dr. Ballard, in the same work I have referred to, on page 241, speaking of the care to be taken in selecting cases for vaccination, says :—"He (the vaccinator) should remember that the vaccine disease is one which is not natural to man ; that it is planted on a soil to which it is *foreign* ; and that it requires constant watchfulness and judicious cultivation to restrain its *inherent* disposition to deteriorate." This passage clearly shows Dr. Ballard's view of cow-pox, and helps to explain his advocacy for animal vaccination on page 253.

The arguments which I shall at first bring forward in favour of the view of the direct relation between cow-pox and small-pox are those derived from the special characteristics of cow-pox in the cow when compared with small-pox in man. It is generally admitted that the cow-pox is propagated among the cows by milking ; and those who have paid most attention to the subject are agreed that it is never transmitted from one animal to another except by direct contact. The disease is never—like small-pox—conveyed by exhalations, *i.e.* through the medium of the atmosphere. Thus it is that only *milk cows* suffer during epidemics. Jenner was convinced of this. On page 86 of his 'Inquiry into the Causes and Effects of Variole Vaccine,' published in 1801, he writes :—"It has been conceived to be contagious among cows without contact ; but this idea cannot be well founded, because the cattle in one meadow do not infect those in another (although there may be no other partition than a hedge) unless they be handled or

¹ By animal vaccination is meant that practice by which from an original case of cow-pox the virus has been transmitted from animal to animal without ever in its descent having passed through a human being.

milked by those who bring the infectious matter with them ; and of course the smallest particle imaginable, when applied to a part susceptible of its influence, may produce this effect."

Ceely also, in his 'Observations on the Variolæ Vaccinæ,' published in 1840, from the 'Transactions of the Provincial Medical and Surgical Association,' writes : "It is considered that the disease is peculiar to the *milch cow*, that it occurs primarily when the animal is in that condition, and that it is casually propagated to others by the hands of the milkers. . . . I have frequently witnessed the fact that sturks, dry heifers, dry cows, and milch cows, milked by *other* hands, grazing in the same pastures, feeding in the same sheds, and in contiguous stalls, remain exempt from the disease."

Both the above observers, then, agree in thinking the disease is seldom, if ever, conveyed from one animal to another except by direct contact.

Another fact may be mentioned here, showing, as far as it goes, the same thing. During the practice of animal vaccination there is not a single instance on record, as far as I have been able to ascertain, of one animal becoming affected from another except by direct inoculation. Now, since in animal vaccination the true cow-pox, unmodified by transmission through man, is supposed to be conveyed, this fact is of some significance.

It will scarcely be necessary to consider further evidence on this point, as I know of no observation tending to the contrary conclusion, except some experiments made in India, in 1832, and of which I shall speak further on.

How, then, does the disease arise ? Jenner suggests its origin from the sore heels of horses, and no one reading his work will think that he arrived at this conclusion without due observation. This opinion of his, it is true, is no longer entertained, partially because the variolous affection of the heels has been ignorantly confounded with the grease, and partially because the explanation does not account for the origin of all cases of cow-pox ; but that this is the way in which the disease has occasionally been communicated to the cow seems more than probable.

Other observers, such as Ceely, offer no explanation of the origin of cow-pox.

Before reflecting further on the above peculiarity of cow-pox it will be convenient to consider another, and that is, its localisation to the udder and teats. All observers are agreed upon this point. The disease is conveyed by the milkers to the udder and teats, on which vesicles are formed, but on no other part of the body do vesicles appear. Moreover, for the conveyance of the disease, it is known that the healthy hand is quite as efficacious as when it is itself affected.

Horse-pox seems also to have both the above-mentioned peculiarities of cow-pox, the only difference being that in the horse the disease is localised at the heels instead of at the udders. Horses, however, often inoculate their mouths and mucous membrane of their nose by biting their already affected and itching heels.¹

Mares suffer quite as much as horses do from the disease, whereas in cow-pox the females alone are affected.

It is stated that in Asia, in the province of Lus, the milkers have a disease long known as photo-shooter, contracted from milking the camel, in the same way as cow-pox is contracted from milking the cow, and that it has been found to be equally protective against the small-pox.²

Now, it is very remarkable that the cow and horse, and perhaps the camel, should each be liable to a disease (producing vesicles so exactly like those of small-pox, and that the virus from them, when used on man, protects him from small-pox) on those parts of their bodies which are mostly brought into contact with the hand of man. It thus appears that if cows were not milked and horses were not shod their respective varioloid diseases would cease, as far as we can see, to exist.

In order to account for the continuance of the disease it seems almost necessary to suppose that it is a derivative from small-pox, and, consequently, that if small-pox became extinct cow-pox and horse-pox would exist no more. This supposition obtains much support when we find that cow-pox has chiefly been prevalent during great epidemics of small-pox, and that since small-pox has been diminished by vaccination cow-pox has become much less prevalent. The latter fact is

¹ Seaton's 'Handbook of Vacc.,' p. 27.

² Article by A. W. in 'Once a Week,' July 4th, 1863, p. 36.

especially remarkable, for we should have expected that with the general distribution of cow-pox virus over the land cow-pox would have increased rather than diminished.

That cow-pox does prevail chiefly during great epidemics of small-pox, and that it is more rare now than formerly, are facts, I think, generally admitted; however, the following reasons for thinking so may be given.

On reading Jenner's treatise, 'An Inquiry into the Causes and Effects of the Variolæ Vaccinæ,' one is at once struck with the frequent occurrence of the disease in Jenner's immediate neighbourhood, viz. Berkeley in Gloucestershire. He mentions it incidentally as occurring—

In 1759	.	.	.	.	on p. 47
„ 1760	.	.	.	.	„ 13
„ 1765	.	.	.	.	„ 11
„ 1770	.	.	.	.	„ 9
„ 1780	.	.	.	.	„ 20
„ 1782	.	.	.	.	„ 22 and 23
„ 1791	.	.	.	.	„ 21
„ 1794	.	.	.	.	„ 21
„ 1796	.	.	.	.	„ 15 and 16
„ 1798	.	.	.	.	„ 47

Besides these incidental references, we have this notable passage on page 44, from which we may infer that the cow-pox was then almost of yearly occurrence.

Having broken off his observations on the disease in 1796, he writes in 1801 :—“The spring of the year 1797, which I intended particularly to have devoted to the completion of this investigation, proved, from its dryness, remarkably adverse to my wishes, for it frequently happens while the farmers' horses are exposed to the cold rains which fall at this season, that their heels become diseased, and no cow-pox then appeared in the neighbourhood.” The disease, however, did appear the following year, viz. in 1798.

Nobody at the present time would confidently look forward to the return of cow-pox in order to complete observations commenced the previous year.

From 1838 to 1841 cow-pox seems to have again been frequent in England. It was during these years that most of the new stocks of vaccine lymph arose. Mr. Estlin met with

the disease in Gloucestershire, and raised a fresh stock of vaccine lymph; Mr. Fox and Mr. Sweeting also met with the disease in Dorsetshire, and raised lymph stocks.

Dr. Seaton, in his 'Handbook of Vaccination,' page 414, remarks concerning this:—"It is certainly very singular that it (cow-pox) should have been seen by so many observers about the same time, and it deserves particular notice that this was at a period when one of the most formidable epidemics of small-pox that has occurred in the present century was sweeping over the land."

Concerning the rarity of the disease in 1840, Mr. Ceely, in discussing Dr. Sonderland's (of Bremen) article in the 'Medical Gazette,'¹ November 9, 1831, says on page 94 of his work, 'Observations on the Variolæ Vaccinæ:' "The result of careful and extensive inquiry induced the belief that the asserted comparative rarity of the disease was true as regarded this neighbourhood." On page 47 he says: "I am inclined to believe from all the information I have been able to procure that the cow-pox is not so often met with as it was forty or fifty years ago, but upon this point I speak with much hesitation." Mr. Ceely, be it remembered, was then writing at a time when cow-pox was more prevalent at Aylesbury than it had been for some years past and than it has been since.

Horse-pox also seems liable to prevail during epidemics of small-pox. In the account of the disease at Rheims, in 1860, it is expressly stated that human small-pox was *very* prevalent at the time. See Ballard, 'Prize Essay,' p. 32.

Now it appears likely, since small-pox and cow-pox are so similar, if not directly related, that the same conditions existing at certain times would be favorable to the spread of both diseases, and this might be given as a reason for the prevalence of the two together, but against this we may reasonably suppose that if it had not been for vaccination epidemics of small-pox would have been more frequent and more widely spread than they have been during this century (see Dr. Ballard's 'Prize Essay,' p. 71 *et seq.*), but where, then, are the corresponding epidemics of cow-pox, which should have

¹ See extract in 'Med. Gaz.,' November 9th, 1831, taken from 'Journal des Praktischen Heilkunde,' January, 1831.

occurred if cow-pox be an independent disease? They also, together with the small-pox epidemics, have decreased.

It has been urged that the milkers are now all vaccinated, and therefore are less likely to become affected with the natural disease, and therefore do not so readily convey the disease, but this cannot be the explanation, for the healthy hand seems to convey the disease from one animal to another quite as readily as the affected hand; besides, the disease must incapacitate those suffering from it from doing their work as milkers—at all events for some time during its progress. This, however, is beyond the point, for it is not contended that the disease spreads less on a farm now than formerly, but that for years together it does not exist at all.

But besides the indirect evidence given above we have positive evidence to bring forward to show that small-pox may be communicated by inoculation to horned cattle, and that the resulting vesicles yield lymph, having all the properties of vaccine lymph. In other words, small-pox, by one transmission through an animal, becomes modified, so that it is not only no longer infectious, but also is limited as far as regards the eruption to the points of inoculation.

Dr. Gassner,¹ of Gunzburg, so early as 1801, succeeded in inoculating a cow on the eleventh experiment with the small-pox virus, and used the lymph thus obtained for vaccinating four children, and from them seventeen others. No small-pox appeared among these children.

In 1836, and again in 1838, Dr. Theile, of Kasan, succeeded in inoculating the cow with small-pox matter, and he used the lymph for the vaccination of children. He thus states his conclusions on this point:

“1st. The so-called vaccine is not an eruptive disease peculiar to the cow, but is produced in it by the transmission of human small-pox to it; and the man, and not the cow, as has hitherto been thought, is the source of the disease.

“2nd. The mild disease thus caused in the cow can, by direct transmission from the cow to man, produce in him as mild a disease, which gives protection against the natural small-pox.”

¹ Heim in Henke's 'Zeitschr. Ergänzungschrift,' xxx, p. 57; also 'British and Foreign Medical Review,' January, 1840.

His other conclusions refer to an artificial method of producing this modification in small-pox virus without the aid of the cow. This he thought he did by preserving small-pox virus for ten days between two pieces of glass, and then diluting it with milk and using this mixture for vaccinating children. The lymph obtained from the resulting vesicles he again kept and diluted with milk as before. After ten generations the lymph had become modified, and could be used without the addition of milk.¹

Mr. Ceely, in 1839, also succeeded in inoculating cows with small-pox, and found that the resulting lymph caused a disease identical with vaccinia. His experiments are published in the 8th vol. of the 'Transactions of the Provincial Medical and Surgical Association,' and also in a separate work, entitled 'Observations on the Variolæ Vaccinæ,' 1840, Worcester. In a note, p. 140, of the latter, which I quote to show that his experiments were independent of Dr. Theile's, he says: "But I am gratified to learn that since the announcement of those [experiments] which I have just detailed, intelligence has been received of the success of Dr. Basil Theile, of Kasan, in Russia, in similar experiments."

He also, on the same page, states that when he wrote, more than 2000 subjects had been vaccinated with his variola vaccine lymph. About this time also Dr. Reiter, of Munich, succeeded. He had failed previously, but having adopted the method of inoculation practised by Dr. Theile, he succeeded. In 1840, Mr. Badcock, then a chemist in Brighton, succeeded on his first attempt, and afterwards succeeded some thirty or forty times; nevertheless his successes only amounted to about 7 per cent. of his trials.² Some of the lymph thus obtained by Mr. Badcock, so he informs me, furnished the stock which was used at the Highgate small-pox and vaccination hospital for some fifteen years or more by Mr. Marson.

Dr. Vy,³ of Elburg, in 1867, also succeeded, and used the lymph for vaccination.

¹ Henke's 'Zeitschrift für die Staatsarzneikund,' 1839.

² 'Detail of Experiments proving the Identity of Cow-pox and Small-pox,' Brighton, 1845.

³ 'Bulletin de l'Acad. de Méd.,' t. xxxi, p. 430.

Most, if not all, experimenters who have succeeded, agree that there is considerable difficulty in obtaining a characteristic pock on the cow from inoculation of small-pox ; and, indeed, there are not a few who have entirely failed.

Mr. Marson tried forty times in succession without result ; so also Coleman, King, Dalton, Sacco, Fiard, and Bousquet. M. M. Chauveau, and associated with him M. Viennois and Meynet, however, strange to say, succeeded almost *every time* ; but what they produced were papules, and from these papules they obtained lymph which produced *small-pox*.

I have myself tried twice to inoculate calves, and on both animals papules were the result, such as, I presume, were produced by M. M. Chauveau's inoculations ; but I could not have taken lymph from them without danger of taking up some of the original small-pox matter with which the places had been deluged. A reference to the drawings of Mr. Ceely, published in the 8th vol. of the 'Transactions of the Provincial Medical and Surgical Association,' will show how different were his results. No doubt he often produced papules, but these he regarded as failures, indeed, he describes them as being produced on the very animal from which his drawings were afterwards taken in his first attempt to inoculate it. It is only when a characteristic vesicle is produced, such as that obtained by Mr. Ceely, that we can be certain of our success.

Small-pox is also said to have resulted from experiments similar to those of M. Chauveau, at the Veterinary School of Berlin, and also at Boston, U.S.¹

In these experiments, however, there is no evidence to show that the original small-pox matter may not have been taken up again and used unchanged for the inoculation rather than the vaccination of children.

I have mentioned that the inoculation of small-pox on animals is a difficult matter, and only a few succeed. Such, however, is not the case when animals are vaccinated with current, *i. e.* humanised lymph. This fact requires some consideration, because it can be urged in support of the view that small-pox and cow-pox are distinct diseases. I would remark that this fact could be urged with much greater force

¹ See Seaton's 'Handbook of Vacc.,' p. 55.

if the virus of small-pox was taken under circumstances similar to those under which the vaccine lymph is taken—that is, from inoculated vesicles on the eighth day. In all the experiments of inoculation of small-pox on animals the virus has been taken from the natural disease in man, not from the primary pocks of the inoculated disease. There is certainly some difference, as I will try more fully to point out. The general eruption of inoculated small-pox appears some two or three days after the perfecting of the primary pocks, or those produced at the sites of inoculation. To show that secondary *vaccine* pocks do not always produce the same effects as primary vaccine pocks, I will detail the two following experiments.

Experiment 1.—In December, 1875, I vaccinated eight children from a child, E. C—, whom I had first vaccinated on the 15th of December, *i. e.* fourteen days previously. The child E. C— had returned on the 22nd December for inspection, but I found that only two very small vesicles were visible. I revaccinated the child on the 22nd in four other places. When it was brought back on the 29th all the four other places were found to have taken, and they presented much the same appearance as the two first vesicles then had. The six places were still all vesicular, and not much inflamed. The course, therefore, of the vaccination was much delayed. It was from the four secondary places that I took lymph to vaccinate the eight children. Of these eight children, each vaccinated in four places, three of them had two, two, and three places respectively which apparently took ; but none of these places became characteristic vesicles, only sores with yellow crusts. One of the children that had taken in two places was revaccinated on the 12th of January, 1876, and had four characteristic vesicles. The other was revaccinated on the 8th of March, 1876, and had four good characteristic vesicles. The child that had taken in three places was vaccinated on the 3rd of May, 1876, which resulted in five good characteristic vesicles. Four of the others on whom no effect had been produced were subsequently revaccinated with perfect results.

From this series of cases I think we may conclude that

lymph taken from late vesicles cannot be relied upon to produce the same effect as lymph taken on the eighth day.

Experiment 2.—Occasionally a vesicular eruption breaks out after vaccination. These vesicles are exceedingly like those of varicella with depressed centres. I have seen it at least three times. On one occasion, February 6th, 1878, I used the lymph taken from a vesicle on the buttocks of a child who had this eruption for the inoculation of another. No result followed.

Another consideration leads also to the opinion that the difficulty in inoculating animals with small-pox virus arises from the dissimilarity of conditions under which the small-pox virus is taken, and it is this:—If the difficulty arose from the fact that we were trying to inoculate small-pox upon a foreign soil, *i. e.* the body of the animal, why should not the same difficulty arise in inoculating cow-pox upon a foreign soil, *i. e.* upon man? That the latter does not hold to anything like the same extent is evident from the results of vaccination with animal lymph. I will briefly mention one other fact bearing upon this part of our subject, *viz.* that the present success in vaccinating heifers, the one from the other, in animal vaccination, was not attained until the proper time for taking the lymph had been ascertained by experience. The many failures were due to taking lymph at too late a date.

It scarcely needs to be pointed out that no inference in favour of cow-pox being an independent disease can be drawn from the fact that it is capable of being transmitted through a long series of animals, from one to the other, because a similar fact is observed even more strongly in ordinary vaccination. Thus among 200 children vaccinated consecutively from arm to arm, each child having five places, I find that only 28 of the 1000 places failed to take; and among 3000 children 2996 were successfully vaccinated on the first attempt. This uniform susceptibility existed even in a child whose mother had undergone a severe attack of small-pox while pregnant, and although the case does not strictly bear upon the present argument, I mention it on account of its independent interest. The case is briefly as follows:

Elizabeth E—, residing at 17, Church Street, Blackfriars Road, gave birth on the 14th December, 1877, to a child at full time. On the 13th of June previously, and consequently when about four months pregnant, she had been admitted into the Small-pox Hospital at Hampstead suffering from an unmodified attack of small-pox. On the 21st of May, 1878, she brought her child to the Surrey Chapel station for vaccination. She was then deeply pitted, and had lost most of her hair. The child showed no evidence of having had the disease. It was vaccinated, with the result of having five good characteristic vesicles, which went through a regular course, except that the areola on the eighth day was well developed.

From what has just been said it would appear probable that the difficulty experienced in inoculating animals with small-pox virus as compared with that experienced in vaccinating them arises from the dissimilarity of conditions under which the virus is taken, and on the whole I think we are justified in considering it proved that it is possible to inoculate cows with small-pox, and that the virus by one transmission through the animal becomes modified in that the disease produced by its inoculation back on man is no longer infectious, and that the eruption is, with few exceptions, limited to the places of inoculation.

The next point in our argument will be an endeavour to show that vaccine lymph tends to deteriorate more rapidly when passed through a succession of heifers than it does when passed through a corresponding number of children.

The evidence, however, on this point is suggestive rather than demonstrative, and I do not wish to lay much stress upon it. I submit it for what it is worth. From Marson's statistics (a copy of which is given on the next page) it may be seen that those having slight vaccine scars are not, as a rule, so well protected against death from small-pox as those having good ones. Lymph, therefore, which persistently leaves slight scars may be considered weak, whatever characters it may manifest during its active course. Now, I think from the observations of others, confirmed by my own limited experience, that a lymph stock which gives rise to vesicles which run their course rapidly, as manifested by

an early and in many cases extensive areola, is one which gives, as a rule, superficial scars. It is worthy of remark that an early and extensive areola is also characteristic of many cases of revaccination, yet the resulting scars are generally insignificant. Now, if we compare Jenner's and Ceely's description of cow-pox with the descriptions of those who have practised animal vaccination, we are at once struck with the rapidity with which the disease in the animal now runs its course. Instead of the vesicles taking eight or nine days to reach perfection, as mentioned by Mr. Ceely,¹ we are told that the fifth day is the proper time for taking the lymph, and that the whole course of the disease is run in ten days.

Dr. Martin says:²—"From the insertion of the virus (on the animal) till the crusts fall is often not more than ten days or even nine days. It may be said that the vesicles

¹ 'Observations on the Variolæ Vaccinæ,' p. 69.

² 'Journal of Boston Gynæcological Society,' April and June, 1872, p. 277.

STATISTICAL EVIDENCE of the different degrees in which persons vaccinated in different ways will be safe against death by small-pox, if they should happen afterwards to contract this disease.

The Table is founded on information given to the Medical Officer of the Local Government Board by Mr. MARSON, Surgeon of the Small-pox Hospital, as the result of his observations made during 25 years in nearly 6000 cases of post vaccinal small-pox.

Cases of small-pox, classified according to the vaccination-marks borne by each patient respectively.	Number of deaths per cent. in each class respectively.
1. Stated to have been vaccinated, but having <i>no</i> cicatrix	21 $\frac{1}{2}$
2. Having <i>one</i> vaccine cicatrix*	7 $\frac{1}{2}$
3. Having <i>two</i> vaccine cicatrices†	4 $\frac{1}{2}$
4. Having <i>three</i> vaccine cicatrices	1 $\frac{1}{2}$
5. Having <i>four or more</i> vaccine cicatrices	$\frac{3}{4}$
Unvaccinated	35 $\frac{1}{2}$

* Among cases in which the one cicatrix was *well marked*, the death-rate was 4 $\frac{1}{2}$. Among cases in which it was *badly marked*, the death-rate was 12.

† Among cases in which the two cicatrices were *well marked*, the death-rate was 2 $\frac{1}{2}$. Among cases in which they were *badly marked*, it was 7 $\frac{1}{2}$.

in the animal are always perfectly desiccated and effete as early as the tenth day. If the scabs remain adherent longer it is from the hairs."

Dr. Martin was here speaking of the results produced by the lymph at about the three hundredth remove. We have an account of the results produced by the same stock of lymph, viz. the Beaugency stock, by M. Depaul,¹ at the forty-second remove. I will quote Nos. 9, 10 and 12 of his conclusions.

"9. We have established that the progress of the eruption upon the heifers was a *little more rapid* than that of the vaccine pustule in the human species.

"10. The elevation has almost always begun to appear in the course of the third day, and, as a rule, suppuration commenced in the course of the seventh or eighth day.

"The eruption has shown itself exclusively at the points of inoculation, and we have never been able to detect any pustular appearances on other parts of the skin or at the mucous orifices."

From these different descriptions of the disease by three different observers, at three different periods of its descent, we are justified in thinking that the disease gradually becomes accelerated in its course, and that this acceleration has been more excessive and more rapid in its development in animals during animal vaccination than it has been in man by arm-to-arm vaccination. It is contended, however, for animal vaccination that, notwithstanding the rapid course of the disease in animals, yet that when used for the vaccination of children the course of the disease is retarded instead of hastened, and causes larger and better scars. I have twice used lymph reputed to have been of animal origin.

1st. On the 3rd of July I vaccinated a child with some lymph on three points kindly sent to me by Dr. Wyld. It was certainly true in this case that the course of the vaccination was prolonged, and that the resulting scars were good; but it is to be remembered that the lymph was preserved on points, and there is no doubt about the fact that

¹ "Expériences faites à l'Académie Impériale de Médecine avec le Cow-pox on Vaccin Animal depuis le 12 Avril jusqu'à la fin de Décembre de l'année, 1866," 'Compte rendu,' 1867.

preserved lymph often gives rise to delayed vesicles. It is not until we vaccinate from arm to arm that we can judge of the quality of a lymph stock. In order, therefore, to form a better opinion of the lymph supplied me, I vaccinated two children directly from the one I had vaccinated from the points. In both these the course, instead of being retarded, was accelerated. The arms on the eighth day were considerably more advanced than those vaccinated with the current lymph. The scars of one of these children I saw on the 20th of March, 1879. They were of good extent, but superficial. The other child I was unable to find.

The other occasion on which I used animal lymph was on the 29th of May, 1878. It came from Brussels in a bulbed capillary tube and was mixed with glycerine. It gave rise to five small vesicles containing a thin watery lymph.

Not only from preserved lymph, but also in some sickly children done from arm to arm, especially those that have taken mercury, the course of the disease is occasionally retarded, so that the vesicles go on increasing in area considerably, after the eighth day, with very slight areola, and resemble much the vesicles I have seen from the use of animal lymph.

My last endeavour will be to answer an objection that has been urged against the view supported in this thesis, and it is this, that, although cow-pox now is only propagated by direct contagion, yet that it has existed in an epidemic form among horned cattle in England, and still occasionally occurs as such in India.

Baron, in his 'Life of Jenner,' p. 234,¹ says: "I think there is good ground for believing that the disease, as originally noticed by Dr. Jenner, was the epidemic or local remains of the more general or epizootic disease which prevailed in many parts of this island at the period when Dr. Layard wrote."

He here refers to the epidemic described by Dr. Layard,² which occurred in 1745 to 1756, and again from 1760 to 1770. This epidemic Dr. Layard considered to be of the variolous kind. He says: "It bears all the characteristics,

¹ Baron's 'Life of Jenner,' 1827.

² 'Philosophical Transactions' for the year 1780.

symptoms, crises, and events of the small-pox, and whether received by contagion or by inoculation has the same appearances, stages, and determination." Yet his subsequent description of the disease is not altogether consistent with this statement.¹

This opinion of the nature of the epidemic continued until 1865, in which year the cattle plague made its appearance in England. It was soon recognised to be identical with the disease described by Layard, and its likeness to small-pox was again insisted upon by several, among whom was Dr. Murchison.

In the report of Dr. Murchison to the Privy Council he gives this likeness as a reason to try the effect of vaccination on the disease; and again, writing to the 'Times,' after this had been tried and found of no avail, he says: "The points of resemblance between cattle plague and small-pox are so striking that certain observers were led to hope that vaccination might protect," &c.²

The above quotation is sufficient to show that the cattle plague did bear some resemblance to smallpox, but the following established points of difference will prove that they are not identical diseases, are not any more related than scarlet fever is to measles.

1st. The amount of the eruption in cattle plague bears no relation to its fatality, which is certainly the case in the great majority of the cases of small-pox.

2nd. The eruption in the two diseases is anatomically different.

3rd. When cattle plague is conveyed by inoculation from one animal to another there is no local development at the seat of inoculation, as occurs when small-pox is inoculated.

4th. Vaccination has been found to afford no protection against cattle plague.

We must, therefore, no longer regard the epidemics of 1745 and 1760 as in any way related to small-pox.

I have now to speak of the disease known in India under the names of bussunt, mhata, or gotee.³ It is thus described

¹ See Appendix.

² Letter of Dr. Murchison to the 'Times,' January 30th, 1866.

³ 'Trans. of the Medical and Physical Society of Calcutta,' vol. viii.

by Mr. Lamb :—"The animals which were at first affected had been for a day or two previously dull and stupid ; they were afterwards seized with cough and much phlegm collected in their mouths and fauces. The animals had at this time no inclination for food. There is a discharge of saliva from the mouth, then follow universal tremor, and great heat of the head, chest, and body as far back as the loins, while the hind quarters are cold ; the whole body then becomes hot, and the animals suffer from intense thirst. The mouth and fauces appear to be the principal seat of the disease, being in some instances one mass of ulceration. On the fifth day the eruption appears about the udder, sometimes only a few pustules, and at other times they were numerous and confluent, but the results of the attack does not appear to depend much on the eruption. Whether the pustules are numerous or rare, the disease is nearly always fatal, and unless measures are taken to separate the diseased from the healthy, it speedily runs throughout the whole herd, sparing few.

"In those who do escape after taking the infection, the favorable symptom is a spontaneous diarrhoea, in which the dejections are large, watery, and offensive. Many die before the eruption makes its appearance, but the fever is always known by the discharge of the saliva."

Mr. Macpherson, Superintendent of Vaccination at Moorshedabad, tried inoculating this disease on children in 1832, hoping thereby to obtain a new stock of vaccine lymph, and he describes his experiments in the following words :¹

"All the cattle in the neighbourhood became affected, and amongst others, two belonging to one of my own vaccinators. I had them covered with blankets, leaving merely the udder and teats exposed to the air. On the seventh day two small pustules made their appearance on the teats of one, which dried up on the tenth, and the crusts were removed on the twelfth day. From these crusts eleven native children were inoculated, one of them successfully, a vesicle appearing on the fifth day, which continued to increase till the ninth day, when it had all the characters of

¹ 'Trans. of Med. and Phy. Society of Calcutta,' vol. vi ; also Duncan Stewart's 'Report on Small-pox in Calcutta,' 1844, pp. 84 and 85.

true vaccine ; the child suffered much from fever for four days. Two children were vaccinated from this vesicle with complete success, the symptomatic fever being very severe ; from these two children five others were successfully vaccinated, and the stock thus established was afterwards regularly continued. Some of the children vaccinated with this lymph were tested by variolous inoculation and exposure to variolous infection and found secure.”

Dr. Seaton, commenting upon the above-related experiments, very justly remarks :¹ “ From these facts it is not to be doubted that a case of cow-pox in the cow had been met with ; but what is to be doubted is that the gotee, the malignant disease above referred to, was the source of infection, for the eruption, so far from being like that said to be prevalent, viz. one of pustules all over the body, terminating in ulceration, was a couple of pustules (vesicles) only, having exactly the characters of an ordinary case of casual cow-pox.” And Dr. Duncan Stewart,² who reports this case, regrets that information was not given more fully regarding the appearance of the disease in the cows from which he took the crusts, one of which succeeded.

In 1833 Mr. Furnell,³ a civil surgeon of Silhat in Assam, having seen a report of Mr. Macpherson’s experiments of the preceding year, determined to repeat them. He commenced by vaccinating four children with the scabs taken from the back of an animal suffering from gotee, but without effect. Having shortly afterwards to leave Silhat on account of his health, he asked Mr. David Brown, then Assistant Surgeon of the Silhat Light Infantry, to continue the experiments. A reward was offered for an animal suffering from the disease, which was shortly obtained. Nothing, however, is said of the symptoms of the disease manifested by the animal, except that it was thin and out of condition. It appears, however, that it had a general eruption, for scabs were taken from the *back* of the animal and used for the vaccination of four children. All these vaccinations were

¹ Seaton’s ‘Handbook of Vaccination,’ p. 64.

² Stewart, op. cit., p. 148.

³ ‘Trans. of the Medical and Physical Society of Calcutta,’ Appendix, p. 453, vol. vii. Mr. Furnell’s account.

successful. The resulting vesicles are said to have run a natural course, and from them four more children were vaccinated. Mr. Brown's¹ words are as follows:—"From this new virus vaccination was carefully propagated through successive numbers of children, by either Mr. Furnell or myself, *or the native vaccinators* under our superintendence, through the months of October and November." On the 23rd of November, 1833, Major Orchard's child and three native children were vaccinated from one child, with this virus, and on the 1st December, *i.e.* on the ninth day, Mr. Furnell vaccinated his own child from one of these native children. A day or two after this, in due time, Major Orchard's child had severe small-pox, and the three native children all had slight but characteristic eruptions. Mr. Furnell's child, also, a week after this, had small-pox of which it died on the 20th December. On making inquiries afterwards Mr. Furnell ascertained that the native child from whom he had vaccinated Major Orchard's child and the three native children had had a general eruption after having been inspected. It could not, however, be ascertained how many of the native children vaccinated during October and November had suffered from small-pox, for no register was kept, and the children after vaccination were not again seen. Mr. Brown, apologising for this, says: "Why more children were not inspected was owing to no register having been kept," and, he goes on to say, "in explanation of this apparent neglect, I may state that the superintendence of vaccination on Mr. Furnell's part and my own was gratuitous, and not considered at the time as part of our duties."

From the account of these last experiments of Mr. Furnell's and Mr. Brown's we are justified, I think, in regarding them of little scientific value.

1st. Because *native* vaccinators conducted some if not most of the vaccinations.²

2ndly. No description is given of the symptoms of the animal from whom the scabs were taken, save that it was thin and had a generalised eruption.

¹ *Ib.*, vol. viii, p. 97. Mr. Brown's account.

² I have been informed by a native medical man that many of the natives prefer inoculation with small-pox rather than vaccination.

3rdly. No register was kept, Mr. Brown apologising for the neglect on the ground that the work was gratuitous.

It is to be remarked that the disease known in India as bussunt mhata or gotee, as described by Mr. Lamb, bears so close a likeness to cattle plague, which is described in the appendix to this thesis, that we are forced to the conclusion that it was cattle plague he saw.

We may further observe that the experiments of Mr. Macpherson were made shortly after the publication of Dr. Baron's 'Life of Jenner,'¹ who, in chapter v, page 161, gives a most interesting and learned disquisition on the history of small-pox, but in which he regards small-pox and cattle plague as identical diseases.

Such are the leading arguments in favour of our proposition. If true, then we must regard small-pox as the source not only of the cow-pox, but also of the horse-pox, Jenner being possibly, and *most* probably, correct in his observations, but mistaken in their interpretation.

APPENDIX.

THE following are extracts from Dr. Layard's essay on the 'Distemper among Horned Cattle which raged in England from 1744 to 1756.'

"Of the symptoms:²

"As we observe in small-pox and all other putrid or eruptive fevers by which human nature is affected in regular progress, so in this pestilential fever is the course of the contagion through its several stages to be traced by the symptoms. All are not equally seized. Many reasons may be assigned for a slight or violent infection, but, according to the degree of infection, the diagnostics or signs are more or less the same.

"The first appearance of this infection is a decrease of

¹ This was published in 1827.

² Extracts from an essay 'On the Nature, Causes, and Cure of the Cattle Plague,' by Dr. P. Layard, now republished from family documents and the original essay. Beverley: J. Kemp and Son, 1866.

appetite, a poking out of the neck, implying some difficulty in deglutition, a shaking of the head, as if the nerves were tickled, a hanging down of the ears and deafness, or dulness of the eyes, and a moving to and fro in constant uneasiness. All these signs, except the last, increase till the fourth day. There is stupidity and an unwillingness to move, great debility, a total loss of appetite, a running at the eyes and nose, sometimes sickness and throwing up of bile, a husky cough, and shivering. The head, horns, and breath are very hot, while the body and limbs are cold. The fever, which was continual the first three days, now rises and increases towards evenings; the pulse is all along quick, contracted, and uneven. A continuous diarrhœa, or scouring of fetid green fæces, a stinking breath, and nauseous steams from the skin affect the air they are placed in. The blood is very florid, hot, and frothy. The urine or stale is high coloured. The roofs of their mouths and backs are ulcerated. Tumours or boils are to be felt under the *panculus carnosus* or fleshy membrane of the skin, and eruptions appear all along their limbs and about their bags. If a new milch cow be thus ill her milk dries up gradually, her purging is more violent, and on the fourth day she is commonly dry. There is such acrimony or sharpness in their dung that a visible irritation is to be observed during some time in ano.

“They groan much, are worse in the evening, and mostly lying down. These symptoms continue increasing till the seventh day of the invasion, on which, generally, though sometimes protracted till the ninth, the crisis or turn takes place.”

On p. 4 he refers to the eruption in the following passage: “They may also be curried the three first days before the pimples come out.”

On p. 7 he refers to abscesses in the horns as follows:—“Nature frequently deposits the morbid matter in the horns.”

Again, on the same page, he refers to the emphysema:—“In the last stage, on the appearance of an emphysema, a swelling or puffing up of the skin, distended with a thin purulent sanies and putrid air, and which is the last effort of nature to throw off this morbid matter, it will be proper to open the swelling.”

On p. 17 there is a summary of Dr. Layard's work :

"Being the results of Dr. Layard's services from 1769 to 1790, which consisted in ascertaining—

"1st. That his opinion formed in 1756, viz. that the distemper among horned cattle is similar to the small-pox in the human body, and is to be managed in like manner as that illness and as the plague, was well founded.

"2nd. That by killing the cattle without effusion of blood by strangling them, and burying them deeply with their whole skins, and avoiding communication of persons and beasts, are the surest means of extirpating the calamity.

"3rd. That by inoculation the sound cattle may be preserved, as is positively confirmed by the great success in Denmark, &c., but that practice is not to be allowed of, except when the contagion has become general in any country.

"4th. That the utmost attention is requisite to prevent the admission of infected cattle, hides, hay, straw, or cloth packages from foreign countries, lest that illness become naturalised and fixed in these kingdoms, as in Holland during many years, which has ceased in Europe since 1780.

"5th. That the variolous contagion is a different disease from the gullsey, which is a putrid sore throat, natural to and common in Great Britain and Holland, as he observed in 1788."

Description of the Cattle Plague, collated from the various Reports on this Disease to the Privy Council. By Drs. SANDERSON, BRISTOWE, MURCHISON, and others. 1866 and 1867.

Symptoms of the Disease taken naturally.

The incubatory period of cattle plague, when naturally taken, seems to be about four or five days ; at the end of this time the first symptom that has been observed is a rise in temperature of a degree or more. The animal, however, still appears in perfect health, so that without the thermometer no symptom could be observed.

Chills and rigors ushering in the disease are exceptional.

If the mouth be examined 36 or 48 hours after the rise of

temperature, a red line will often be seen round the gums, and, further, minute red points, which are raised, may be seen on the surface of the mucous membrane a little below the corner tooth on each side.

In the female the vagina is reddened, and the same kind of red points are seen scattered over it as are seen in the mouth. Up to this day the animal may show no signs of indisposition, but on the following day these are always observed:—The head hangs down, the ears droop, rumination is irregular, food is taken in less quantities, but drink is greedily swallowed, the animal appears listless, and in milch cows the secretion of milk is lessened. The urine is scanty and high coloured, and often contains albumen, the bowels are confined, and, in many cases, the skin is hide-bound. The animal loses strength and weight. The eruption in the mouth, seen first on the third day, has extended; the whole of the surface between the lower lip and the gum is studded with raised groups of elevations, while those previously observed below the corner teeth have coalesced so as to form patches.

On the next day the animal is still worse, diarrhoea succeeds to the previous constipation, and the discharges are often mucous. The pulse is quickened and thread-like, the artery being scarcely affected by the weak blood-wave; the breathing becomes irregular and oppressed, and the so-called eruption may often be found on the back of the neck and shoulders, cough is frequently present, a transparent watery discharge runs from the eyes, and a discharge of clear viscid mucus often hangs from the nostrils, which is highly infectious.

On the sixth day the alterations of the mucous membrane of the mouth have attained their full development, and the under lip is covered with a crust of white opaque material, which is often easily removed. This done, there is seen the red exposed surface of the *membrana propria*. The pulse is extremely weak, the extremities cold, in fact, there is great adynamia throughout the muscular system. This is sometimes so great that it has been looked upon as a paralytic affection due to the condition of the spinal nervous system.

The respiration now is often very peculiar, inspiration is very quick, and this is immediately followed by the closing of the glottis with a sound which can easily be heard; then

follows the expiratory efforts, which are very great, until it overcomes the resistance of the closed glottis. The pause in respiration thus takes place at the time the chest is expanded, and not, as in normal breathing, at the end of expiration.

Occasionally an emphysema may be felt under the skin of the back. This is due to the rupture of the air cells of the lungs, which gives rise to interlobular emphysema of these organs, and the air then makes its way to the posterior mediastinum, and from thence to the cellular tissue of the back.

The alvine discharges are often dysenteric in appearance. In those animals which succumb to the disease death often takes place on the seventh day, and this is unaccompanied with convulsions or other definite symptoms.

The day previous to death the temperature is often observed to have fallen, so that a lower temperature on the sixth day may be looked upon as of ill omen.¹ In animals that recover the temperature continues high (from 40° to 41° C.) for the next two or three days, after which all the symptoms subside. The red patches in the mouth, left by the falling off of the previously described crusts, rapidly heal, as the lesion is a superficial one and usually not attended with ulceration. In a certain number of cases convalescence is protracted, and death may take place some weeks after the acute symptoms have disappeared.

Symptoms of the disease when inoculated.

When the disease is inoculated the period of incubation is shorter than when the disease is taken naturally. There is no local manifestation, such as the development of a vesicle or tubercle, as occurs after an inoculation of small-pox or vaccination, which is a most important distinction.

The slightest scratch is sufficient to inoculate the disease, and the discharge from the nose or mouth is the most convenient for this purpose. There is slight evidence to show that the incubatory period varies according to the stage of the disease in the animal from which the virus is taken. For it

¹ See temp. chart of cattle plague (Chart 2). It may be compared with the temp. chart of vaccination (Chart 1).

was found that virus taken at the later stages of the disease gave rise to the more rapid development of the disease in the inoculated animal than the virus taken at earlier stages. The inoculated disease is almost as fatal as the disease taken naturally.

Vaccination affords no protection to the disease, neither does it modify it in any respect.

Morbid anatomy.

The eruption.—The elevations in the mouth and in the vagina seem to be caused by increased altered growth of the epithelium. Those in the mouth are accompanied with the filament and spores of a fungus similar to that found in thrush of children.

The eruption on the body, for the purpose of description, may be classed under the head of incrustations and elevations.

The incrustations are best seen on the nuchæ and sides of the neck ; they form a thick yellowish coating, by which the hair is firmly matted together, and resembles much the condition of the human scalp when affected with eczema.

The elevations are best seen on the udders, for here they are larger than elsewhere, few being less than one fifth of an inch in diameter. The epithelium on the surface of these elevations is often detached, and when this is the case they are surrounded by a raised border, corresponding to the line along which the cuticle surrounding them is still adherent to the deeper structures.

There are also large soft elevations, due to the enlargement and inflammation of sebaceous follicles. No true vesicles, such as are seen after vaccination, ever exist.

Alimentary canal.—The changes in the mouth have already been described. The rumen and reticulum are generally healthy. In the omasum the food found in it is dry and adheres to its mucous membrane. The abomasum or fourth stomach nearly always shows evidence of disease ; it is congested, and often patches of submucous hæmorrhage are evident ; besides which ulceration of the folds of its mucous membrane are frequently observed.

The intestines are usually congested throughout, and sub-mucous hæmorrhage may exist. In the cæcum the swollen mucous membrane surrounding Peyer's patches, which are by no means necessarily implicated, is on the same level with or even higher than the patches themselves.

In the rectum the congestion is generally the most marked, the mucous membrane being quite dark.

Respiratory tract.—Here, also, congestion, accompanied or not with submucous hæmorrhage, is present. In the trachea and larger bronchial tubes a diphtheritic exudation of more or less firmness is very constantly found.

In the lungs interlobular emphysema is not unusual, and when present is readily recognised.

Heart.—This is usually empty. In the left ventricle effusions of blood beneath the endocardium were often observed, especially during the earlier periods of the epidemic.

Muscular tissue.—The muscles are bright red or darker in colour. In their substance entozoon-like bodies have been found constantly to exist. To observe these all that is necessary is to tease a portion of muscle with needles in a drop of water and examine them under the microscope.

The muscles most favorable for their obtainment are the heart, psoas muscle, and especially the muscular structure taken from the submaxillary region. The muscle should be fresh, for when kept these bodies gradually disappear. They are not, however, peculiar to cattle plague, for they have been observed in pleuro-pneumonia, in foot-and-mouth disease, and are even to be met with in healthy cattle.

CHART 1.—Average temperature (centigrade) of four vaccinated children. The temperature was taken daily in the rectum at 4.30 p.m. The children's ages varied from eight to twenty days. The normal temperature of young children appears to be 0.3° C. above that of adults.

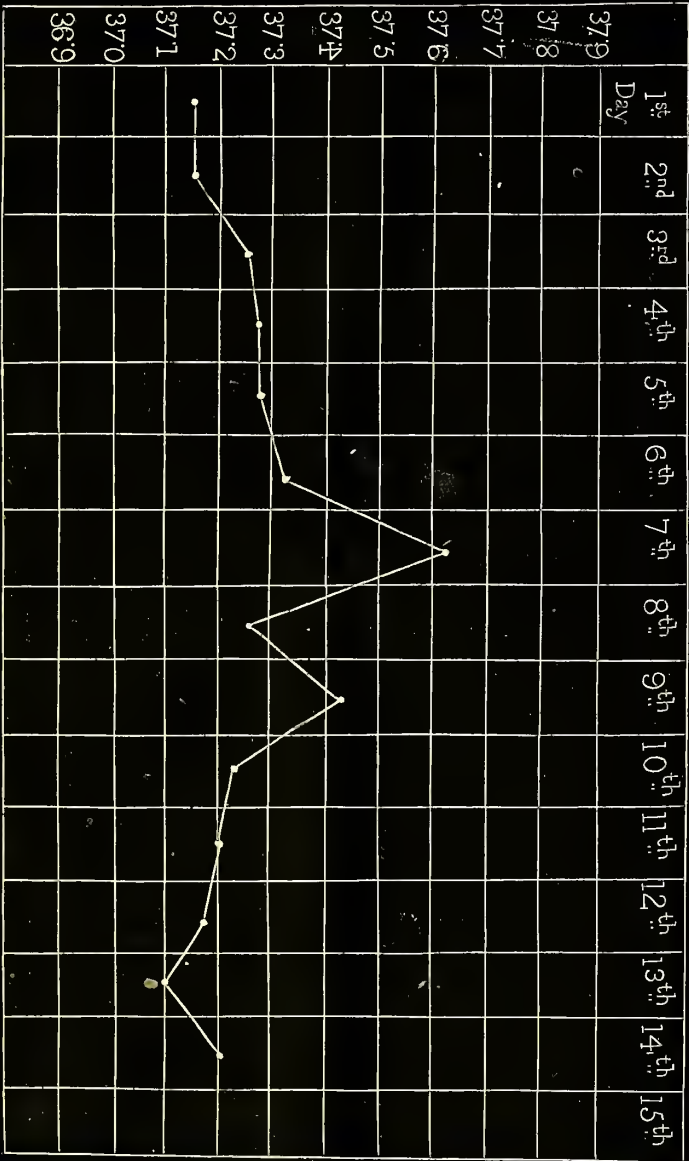


CHART 2.—Average temperature (centigrade) of animals suffering from cattle plague. The entire line represents the temperature of those animals which recovered; the interrupted line of those that died. The normal temperature of grown animals is 38.6°C .; of young heifers, 39.2°C .

